TITLE PAGE

Title: Health Information Technology to Support Clinical Decision Making in Obesity Care

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ABSTRACT

Purpose: Significant health disparities exist with minority youth at risk for obesity and related chronic conditions. School-based health centers provide primary care for many underserved, minority youth; and provide an avenue for addressing these health disparities.

Scope: The comparative effectiveness randomized clinical trial was designed to evaluate implementation of current obesity prevention guidelines into practice in school-based health centers. Twenty-four school-based health centers in six states (AZ, CO, NM, MI, NY, NC) participated in the project.

Methods: The study compared two methods of training providers: web-based training on the guidelines, and web-based training plus computer support for clinical decision making. The health disparities collaborative and chronic care model guided the study.

Results: Participants reported high satisfaction with the virtual collaborative and participation improved providers' adherence to obesity guidelines measured through chart audits and self-report. Parent survey results suggest that the technology had a positive impact on parents' perception of healthcare provider showing confidence in their ability to change their child's diet ($p=.04$) and reports of less disrespectful staff ($p=.03$). Additionally, the technology group had greater improvements in chronic care model elements including patient registry ($p=.02$) and outside referrals ($p=.005$). Further research should evaluate the impact of technology on patient outcomes.

Key Words: childhood obesity, virtual collaborative, decision support technology, tailored patient education, quality improvement, chronic care model

PURPOSE

Objectives:

1. To evaluate the effectiveness of web-based training with and without computerized clinical decision support on provider's process and outcome behaviors related to implementing the current guidelines for prevention of obesity and related conditions.
    a. Process variables include the following:
        i. Provider knowledge, attitudes, and barriers to implementing the guidelines.
        ii. Parent perception of the interpersonal process of care (i.e., provider communication, collaborative decision making, and interpersonal style).
        iii. Parent perception of provider support for their child's healthy eating and exercise.
    b. Behavior outcomes include the following:
        i. Provider self-reported behaviors of identification and assessment of overweight, counseling on nutrition and physical activity, use of behavioral interventions, referrals, and cultural competency.
        ii. Documentation by chart review of: body mass index (BMI) percentile for age and sex; appropriate diagnosis when BMI ≥ 85$_{th}$ percentile; blood pressure (BP) percentile for age, height, and sex; and ordering appropriate laboratory tests when indicated.
2. To explore the role of Health Information Technology in the processes of system change for implementation of the guidelines for prevention of obesity and related conditions including the facilitators, barriers, and impact of the care model on change.

SCOPE

Background and Prevalence

National data suggest that 34% of children 6-11 years old meet the current criteria for overweight or obese (BMI ≥ 85 percentile).[1] Perhaps more troubling is that excess weight in childhood is associated with being overweight or obese as an adult,[2] as well as having increased risk for hyperlipidemia, diabetes, psychological disorders, and other long term health consequences.[3-5] Significant health disparities exist, with 38% of non-Hispanic blacks and 46% of Hispanics overweight or obese compared to 29% of non-Hispanic whites in children 6-11 years old.[1]

Context

School-based health centers (SBHCs) are clinics housed in or linked to a school that provide increased health care access to poor and underserved children, and may provide an avenue to address these health disparities. Access to care, however, does not assure health promotion to prevent obesity. Providers report they are unprepared to address the complex issues of overweight and obese children.[6,7]

With the prevalence of obesity in the previous four decades, and the difficulty in identifying, assessing, and maintaining healthy weight in children, particularly among ethnic minority youth, expert panels have published evidence-based guidelines.[8,9] Despite the publication of these guidelines, research suggests that adherence to following obesity treatment guidelines is poor among primary care providers.[6,7] Obesity care could improve for this high-risk population by using current recommendations, and health information technology (HIT) may facilitate the implementation of guidelines.

Computerized clinical decision support has been developed to promote the use of current practice guidelines by aiding the provider in identifying and assessing overweight/obese children.[10] This type of technology support uses computerized evidence-based algorithms to match individual patient risk factors to patient-specific recommendations. HIT can also provide tailored patient education that provides feedback based upon his or her risk factors and health behaviors. Therefore, this comparative-effectiveness RCT evaluated web-based training with and without computer decision support and tailored patient education on the implementation of evidence-based obesity guidelines in SBHCs that serve populations most at risk for obesity and related chronic conditions.

Setting and Participants

The target population of this research project was SBHC providers who care for children aged 5-12 years. Providers were encouraged to include their practice team in the project – up to three additional team members, such as administrator, support staff, dietician/counselor, and/or school nurse. Twenty-four SBHCs from six

states (four clinics per state) participated in this study. The clients served by these centers are poor, underserved populations from diverse racial/ethnic minority groups (including Latino, African American, Asian, and Native American) that have historically experienced lack of access and healthcare disparities. SBHC inclusion criteria included: SBHC serves children 5-12 years, sees a minimum of 20 children per month for well-child care or sports physicals in 5-12 year olds, has internet access and printer, has space for a small computer in the waiting room or check-in area, and has a primary care provider who reads English. Exclusion criteria included centers that have implemented the HeartSmartKids program.

Parents of 5-12-year-old children seen for well-child care at a SBHC were asked to evaluate care provided to their child. Inclusion criteria for parents include that they read English or Spanish and have a child seen for well-child care or sports physical during the assessment periods. Exclusion criteria are children seen for immunizations, dental, or mental health care without a well-child visit.

OVERALL METHODS

Design

This project used a mixed-methods design combining (a) a prospective, cluster-randomized controlled trial of web-based training with and without HIT decision support for introducing evidence-based guidelines into practice in SBHCs, and (b) focus groups to explore the system change processes, including facilitators and barriers for adopting technology to improve adherence to recommendations for prevention of obesity and related conditions. The study was conducted in partnership with the National Assembly of School-based Health Centers (Now called the School-Based Health Alliance) and the National Association of Pediatric Nurse Practitioners (NAPNAP).

Intervention

Four SBHCs from six states participated and were randomly assigned to one of two intervention groups: (1) web-based training on the guidelines using the adapted chronic care model as outlined below and regular interaction with a virtual learning collaborative; or (2) the web-based training with virtual learning collaborative plus the HIT provider decision support/tailored patient education system, HeartSmartKids.

Group 1: Web-Based Training. The web-based training focused on a practice-based intervention to prevent and treat obesity in children that includes changes at the system level in the healthcare providers' practice and are extrapolated from experience with the National Health Disparities Collaboratives on Asthma, Diabetes, and Depression.[11] The evidence from these collaboratives suggests that the practice changes may improve care to prevent and treat obesity in children. This collaborative model of practice training for the health care system change to promote evidence-based obesity care involved an interdisciplinary team completing four virtual collaborative, multicomponent modules over a 12-month period (see Table 1), with intermittent follow-up via a virtual learning community to encourage continuous monitoring of practice changes and patient outcomes. A major distinction of this model is that the training was directed at practice teams comprised of up to four members that included the practitioner/physician assistant and may have included other members such as the administrator, support staff, dietician/counselor, and/or school nurse. All practice teams received the AMA recommendations, pediatric metabolic working group recommendations, HEAT^{SM} guidelines, and a resource kit along with web-based training using the care model for childhood obesity. Providers assigned to Group 1 will be referred at the "non-technology group" throughout the report.

Group 2: Web-Based Training and Computer Support. The providers assigned to Group 2 received the web-based training described above plus the HeartSmartKids™ (HSK) system during Learning Session 1. Training for the HSK system was provided as part of the web-based curriculum. Additional support was available via monthly phone calls, email, and telephone consultation with HSK staff. Providers assigned to Group 2 will be referred to the "technology group" throughout the report.

HSK, a bilingual, HIT kiosk system with clinical decision support, generated tailored patient education materials. The HSK system compared lifestyle information gathered prior to the encounter to clinical practice guidelines. Standard growth charts, including BMI percentile, were automatically generated and plotted, to promote greater understanding of the child's growth pattern. Relevant health risks were highlighted in the HeartPrint, a summary of the child's cardiovascular risk factors. The system was used to increase perception of risks and provide suggestions regarding behavior change strategies. In addition, the cardiovascular risk assessment clustered risk factors for provider convenience in identifying the risk of metabolic syndrome. Tailored recommendations gave the provider and the family a starting point for discussions of behavior

change. The cardiovascular risk assessment went home with the family and allowed communication of status to other care providers.

Table 1. Components of the web-based collaborative electronic learning community.

	Topic	Content	Delivery Method
Learning Session 1 (4-5 hrs total)	**Obesity Care Guidelines**		
Module A (1 hr)	Evidence-based obesity care	Obesity, health disparities, current recommendations	Voiced PowerPoint with case-based video vignettes
Module B (1 hr)	Health Disparities Collaborative	Chronic care model (CCM), goals PDSA cycles	Voiced PowerPoint with case-based video vignettes
Module C (1 hr)	Intro Motivational Interviewing (MI)	MI philosophy & skills	Voiced PowerPoint with video vignettes
Module D (1 hr) Group 2 only	Heart Smart Kids training	Equipment use, patient flow, generating handouts	Recorded demonstration
Module E (1 hr)	E-Learning community orientation	Blackboard, chatroom, goal setting and change	Taped webinar & conference calls
Learning Session 2 (2 hrs total)	**Advanced Motivational Interviewing & Chronic Care Model for Childhood Obesity**		
Module A (1 hr)	Advanced MI training	Advanced MI & demonstration	Interactive case-based video vignettes & Webinar
Module B (1 hr)	CCM components resources	Delivery system redesign; patient registries; resources & policy	Voiced PowerPoint with case-based video vignettes & E-Learning community
Module C (variable)	Implementing guidelines	E-Learning community	Chat room, links
Learning Session 3 (2 hrs total)	**Community Collaboration & Partnerships**		
Module A (1 hr)	Cultural competency	Resources located	Interactive case-based video vignettes & E-Learning community
Module B (1 hr)	Advocacy & policy	Local, regional & national exemplars	Virtual city with exemplars & E-Learning community
Module C (variable)	Implementing guidelines	E-Learning community	Chat room, links
Learning Session 4 (1 hr total)	**Summarizing Practice Changes**		
Module A (1 hr)	Practice changes & PDSA	Storyboards posted on Blackboard	Webinar discussion of storyboards
Module B (variable)	Implementing guidelines	E-Learning community	Chat room, links

Measures

Measures used in the research project are described in Table 2. The methods and results for each outcome variable are described in more detail in the next section.

Table 2. Process and outcome variables with measures.

Variable		Measure	Items	R&V
Demographic	Providers: age, gender, practice specialty, years in practice, height, weight	ILSI	15	n/a
Provider Process	**Interpersonal process of care**: communication, interpersonal style & decision making (parent report)	IPC	29	.64-.93 *¤ ß
	Support behavior change for healthy eating (parent report)	HCCQ	6	.92-.96*¤§ ß
	Support behavior change for activity (parent report)	HCCQ	6	.95*¤§ ß
	Knowledge, attitudes, barriers subscales	ILSI	35	.67-.81*
Provider Outcome	**Behaviors**: identification, assessment, behavioral counseling, cultural competency, referral	ILSI	35	.67-.81*
	Documentation	Chart	4	¤
System Changes	Use of elements of the chronic care model in routine care	CCMES	9	.76

* Reliability & validity original instrument
§ Translated/back translated by research team
¤ Face validity established by a panel of PNPs
ß Validation of adapted/translated version

PROCEDURES & RESULTS

Provider Demographics and Technology Utilization

Data Collection

After obtaining provider consent to participate, baseline data and demographics were collected at all sites. The investigators explained the study via phone call accompanied by a PowerPoint presentation of the study and

obtained informed consent. Providers were instructed to fax signed consent forms to the PI and keep a copy. Provider surveys, parent surveys, and chart audits were conducted at baseline (T1), after competition of the training (T2), and six months after completion of the training (T3). The surveys were created using a scannable bubble-sheet format (Teleforms) to decrease subject and staff burden and insure the integrity of data collection. Data were anonymous. A designated staff person faxed the completed forms to the PI daily during the data collection period and stored the original in a locked cabinet at the SBHC. The Teleforms were scanned by project personnel weekly into an SPSS (Version 20, Armonk NY) database. A double check was conducted on a random sample of 20% of the scanned records by another member of the research team.

Data Analysis

All analyses were conducted using SAS statistical software (Version 9.2, Cary, NC). Provider demographics were examined at data collection point (T1, T2, T3) using frequency distributions.

Results

Provider demographics are listed in Table 3. Most of providers were Non-Hispanic white females. The majority of providers were nurse practitioners and the most common specialties reported were pediatrics and family practice. At baseline, 27.3% of providers had been in practice for less than five years, 33.3% for 5-10 years, 21.2% for 11-20 years, and 18.2% for over twenty years and practice size varied among participants.

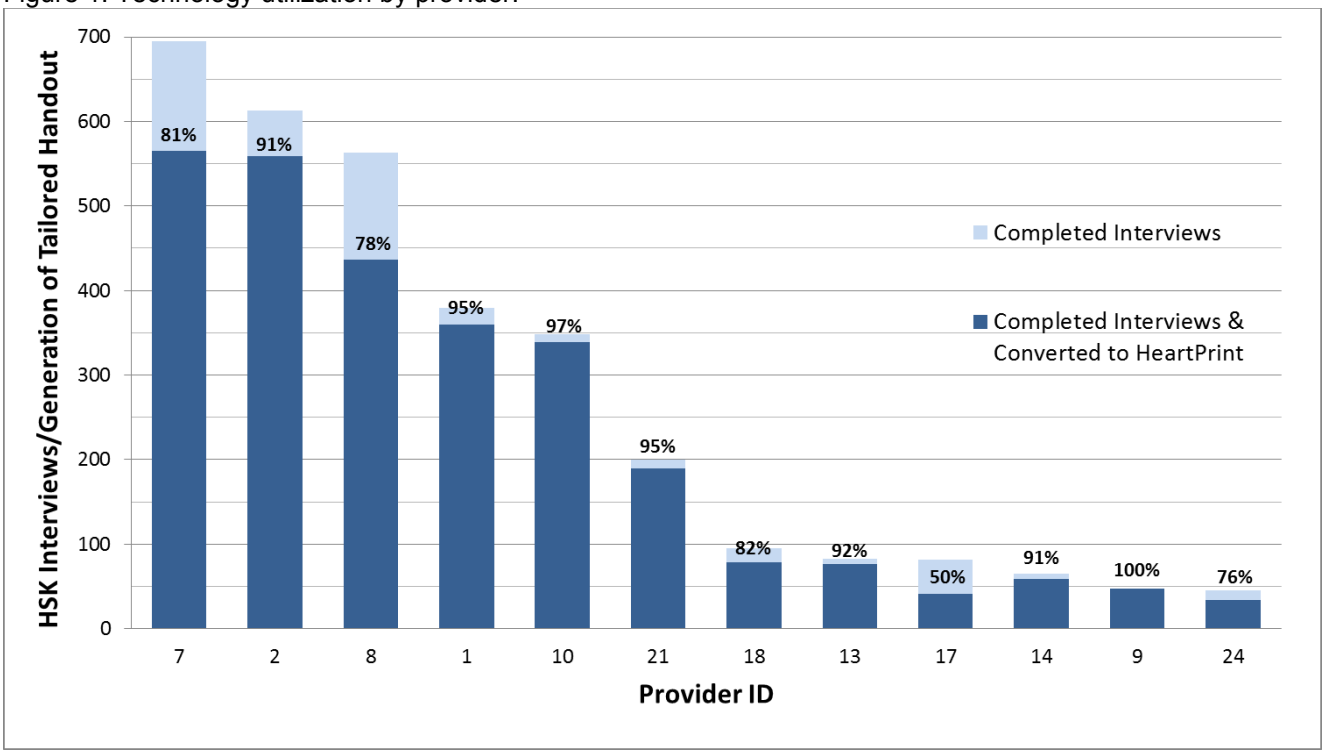
Table 3. Provider demographics.

	T_1 (n=33)		T_2 (n=25)		T_3 (n=23)	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**
Gender						
Female	31	94.0	23	92.0	20	87.0
Male	1	3.0	1	4.0	1	4.3
Did not answer	1	3.0	1	4.0	2	8.7
State						
AZ	7	21.2	4	16.0	3	13.0
CO	4	12.1	4	16.0	4	17.4
MI	5	15.2	5	20.0	4	17.4
NM	6	18.2	5	20.0	4	17.4
NY	5	15.2	3	12.0	4	17.4
NC	6	18.2	4	16.0	4	17.4
Race/Ethnicity						
Non-Hispanic White	27	81.8	20	80.0	17	73.9
Hispanic	4	12.1	2	8.0	3	13.0
Non-Hispanic Black	1	3.0	1	4.0	1	4.3
Asian/Native Hawaiian/Pacific Islander	1	3.0	1	4.0	1	4.3
Mixed/Other	0	0.0	1	4.0	0	0.0
Did not answer	0	0.0	0	0.0	1	4.3
Credentials						
Nurse Practitioner (NP)	23	69.7	19	76.0	16	69.6
Physician Assistants (PA)	5	15.2	3	12.0	4	17.4
Medical Doctor (MD)	4	12.1	2	8.0	2	8.7
Registered Nurse (RN)	1	3.0	1	4.0	1	4.3
Specialty Area						
Pediatrics	15	45.5	15	60.0	12	52.2
General Practice (adults/children)	16	48.5	7	28.0	8	34.8
Other	2	6.0	3	12.0	2	8.7
Did not answer	0	0.0	0	0.0	1	4.3
Patients Seen per Week						
1-30	10	30.3	7	28.0	4	17.4
31-60	16	48.5	11	44.0	12	52.2
61-100	6	18.2	5	20.0	2	8.7
>100	1	3.0	1	4.0	3	13.0
Did not answer	0	0.0	1	4.0	2	8.7
BMI*						
Underweight	1	3.0	0	0.0	0	0.0
Normal weight	19	57.7	16	64.0	15	65.2
Overweight	8	24.2	4	16.0	4	17.4
Obese	4	12.1	4	16.0	3	13.0
Did not answer	1	3.0	1	4.0	1	4.4

*Body mass index: calculated from providers' self-reported height and weight based on the Centers for Disease Control and Prevention formula and classifications.[12]

Twelve sites were randomly assigned to receive technology support in addition to the web-based training (technology group, as described above). Technology utilization of this group was quite varied, as shown in Figure 1. Approximately half of the technology sites used HSK for 200 visits, while the remaining sites had difficulty implementing the technology.

Figure 1. Technology utilization by provider.



Provider Satisfaction with Collaborative

Data Collection

A link was included to complete a satisfaction survey using Survey Monkey (www.surveymonkey.com) after each training module. Each survey contained five questions covering how: well the learning objectives were met, interesting the speaker was, useful the information will be in practice, knowledgeable the speaker was, and useful the audio-visual aids/handouts were. All questions were rated on a 4-point Likert-type scale from strongly disagree (1) to strongly agree (4) or not applicable (n/a). Participants were also asked two open-ended questions: what the provider planned to change as a result of the training and a question for any remaining feedback or comments. Upon completion of each survey, participants were awarded their continuing education credits for that training module.

Data Analysis

Data from each survey was downloaded from Survey Monkey into an Excel spreadsheet (www.office.microsoft.com) that was uploaded into an SPSS database (Version 20, Armonk, NY) and data cleaned and verified. Data analysis was conducted in SAS (Version 9.2, Cary, NC). Descriptive statistics were calculated for provider demographic characteristics as well as satisfaction scores for individual training module surveys and the overall survey. Training module results were first analyzed combining all 17 modules by the five survey questions (learning objectives were met, interesting speaker, information useful in practice, knowledgeable speaker, and useful audio-visual aids and handouts). Training module results were also collapsed into a composite score for six content areas based upon face validity: evidence-based guidelines, MI, CCM, health disparities, advocacy, and culturally-sensitive care.

Results

Of the 24 SBHCs in six states, a total of 36 participants took part in the virtual childhood obesity collaborative. Participants were from Arizona (n=4), Colorado (n=6), New Mexico (n=6), Michigan (n=6), New York (n=8), and North Carolina (n=6). All but one of the participants was female. Participants included: nurse practitioners

(n=21, 58.3%), medical doctors (n=6, 16.6%), physician assistants (n=5, 13.9%), registered nurses (n=2, 5.6%), one health educator (2.8%), and one did not report (2.8%).

The number of participants who completed each training module is presented in Table 4. Completion rates of the first two learning sessions were much higher than the final two sessions. The format for LS3 and LS4 differed from the first two sessions. Despite the outstanding nature of the virtual city experience created by NICHQ with funding from Robert Wood Johnson in LS3, participants struggled with accessing the material that required an additional registration through NICHQ. In LS4, many of the participants in our study had not created a poster before and were overwhelmed with the task, which limited participation. Four participants (11.1%) completed all 17 training modules and 23 participants (63.9%) completed at least 75% of the modules. Six participants (16.7%) completed less than five of the 17 training modules.

Table 4. Participant completion of training modules by content area and learning session.

Content Area	Learning Session	Modules	n[a]	%
Guidelines	LS1	Overview	33	91.7
		Laboratory Screening	29	80.1
		Physical Activity Recommendations	29	80.1
		Nutrition Recommendations	26	72.2
Health Disparities	LS1	Health Disparities Collaborative Approach to Quality Improvement	30	83.3
Chronic Care Model	LS1	Introduction	31	86.1
	LS2	Clinical Information Systems	26	72.2
		Decision Support	24	66.7
		Delivery System Redesign	26	72.2
		Self-Management Support	27	75.0
Motivational Interviewing (MI)	LS1	Introduction	30	83.3
	LS2	Assessing Readiness	29	80.1
		Values Identification	27	75.0
		Implementing MI in Practice	28	77.8
Advocacy	LS3	Be Our Voice	6	16.7
Culturally-Sensitive Care	LS3	Cultural Competency: Providing Culturally-Sensitive Care	18	50.0
Virtual Posters	LS4	Summarizing Practice Changes	10	27.8

[a]The number of participants who completed each module (total n=36).

Participant satisfaction scores are presented in Table 5. Mean satisfaction scores by question type were quite high (>3 out of 4 for all questions). The composite score ranged from 3.66 for knowledgeable speaker to 3.43 for interesting speaker. Satisfaction scores by content area were also high, ranging from 3.63 for motivational interviewing to 3.33 for culturally-sensitive care.

Table 5. Participant satisfaction of training modules by question type and content area.

	Mean	Std Dev	Min	Max	n[a]
Question Type[b]					
Learning Objectives Met	3.63	0.37	2.73	4.00	36
Interesting Speaker	3.43	0.45	2.40	4.00	36
Use Information in Practice	3.55	0.35	2.93	4.00	36
Knowledgeable Speaker	3.66	0.34	3.00	4.00	36
Useful Audiovisual/Handout	3.56	0.38	2.80	4.00	36
Content Area[b]					
Guidelines	3.58	0.38	2.95	4.00	33
Health Disparities	3.48	0.46	2.80	4.00	30
Chronic Care Model	3.53	0.40	2.84	4.00	32
Motivational Interviewing	3.63	0.47	1.60	4.00	31
Advocacy	3.40	0.54	2.80	4.00	6
Culturally-Sensitive Care	3.33	0.73	1.00	4.00	18

[a]The number of participants who completed a survey in each category (total n=36).
[b]All questions were rated on a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree), composite scores were calculated for each category listed.

Provider Process Measures: Parent Perception of Support Results

Data Collection

Providers (or designated support staff) were trained to invite 32 parents who meet the inclusion criteria (listed above) to complete two surveys (IPC & HCCQ) regarding the quality of care at the SBHC. The **Health Care Climate Questionnaire (HCCQ)** is measured with six items each for eating and exercise and assesses the degree of support from healthcare providers for healthy behaviors. For all items, the response values ranged from (1) "not at all true" to (7) "very true" where higher scores were more favorable. The **Interpersonal Process of Care (IPC)** survey is a 29-item survey that measures the patient-clinician relationship, quality, and satisfaction with care on three domains: communication, decision making, and interpersonal style. The IPC includes seven subscales: 1. Hurried communication; 2. Elicited concerns, responded; 3. Explained results, medication; 4. Decision making (patient-centered); 5. Compassionate, respectful; 6. Discrimination; and 7. Disrespectful office staff. All the IPC items ranged from 1 ("never") to 5 ("always"). For some subscales higher scores are more favorable and for others, lower scores are more favorable, as indicated in the results below. School-based health centers allow students to be seen without parents, therefore, we had a difficult time collecting the surveys from parents. The non-technology group had more difficulty than the technology sites in collecting parent surveys (T1 [technology n=336, non-technology n=234]; T2 [technology n=248, non-technology n=68]; T3 [technology n=194, non-technology n=51]).

Data Analysis

Due to low response rates in the non-technology group at T3, only T1 and T2 data were compared for survey score changes. These analyses were conducted in a multilevel framework to account for parent surveys nested within providers. The primary factors of interest were the time main effect (collaborative training effect) and the time by technology interaction (technology support effect).

Results

Parent Demographics

Demographics for the parent surveys at each time point by group are listed in Table 6. The mean age of parents was 33.9 - 37.1 years and mean age of the child was 8.2 – 9.2 years for each time point. The number of male and female children was nearly equal at all time points. The race of the technology group was primarily minority for all time points, however, the non-technology group had 42.7 – 66.7% Non-Hispanic white parents completing the surveys. Equal number of Spanish and English surveys were completed in the technology group, but the non-technology group had more English forms completed.

Table 6. Parent survey demographics.

	T1		T2		T3	
	Tech	Non-Tech	Tech	Non-Tech	Tech	Non-Tech
Number of surveys	336	234	248	68	194	51
Parent Age (Mean ± S.D.)	35.5 (6.6)	34.5 (7.3)	36.0 (6.4)	33.9 (5.6)	36.1 (6.7)	37.1 (6.4)
Did not answer	38	39	52	14	46	6
Child Age (Mean ± S.D.)	8.9 (2.1)	8.2 (2.3)	8.9 (2.4)	8.4 (2.1)	9.2 (2.3)	8.2 (2.2)
Child Gender						
% Female	50.2%	53.5%	45.2%	45.6%	42.9%	54.9%
Did not answer	9	8	7	0	3	0
Child Race						
Non-Hispanic White	25.4%	46.5%	27.5%	42.7%	25.6%	66.7%
Non-Hispanic Black	8.5%	8.3%	12.7%	4.4%	5.2%	19.6%
Hispanic	59.5%	39.5%	55.3%	44.1%	63.4%	3.9%
Other	6.6%	5.7%	4.5%	8.8%	5.8%	9.8%
Did not answer	5	6	4	0	3	0
Insured						
% Yes	67.2%	78.9%	69.4%	75.4%	59.4%	96.1%
Did not answer	34	11	26	3	19	0
Free/Reduced Lunch						
% Yes	84.5%	69.8%	84.1%	79.2%	86.4%	40%
Did not answer	59	22	22	20	25	6
Survey Language						
English	52.1%	74.4%	54.4%	69.1%	46.4%	98.0%
Spanish	47.9%	25.6%	45.6%	30.9%	53.6%	2.0%
Parent Marital Status						
% Married	54.8%	58.3%	60.2%	66.2%	65.4%	68.6%
Did not answer	15	11	12	3	15	0

HCCQ Results

Mean scores for each variable at each time point is listed in Table 7. There was a significant time by technology interaction (p=.04) suggesting the effect of technology improving counseling over time for parents' perception of healthcare provider showing confidence in their ability to make changes regarding the child's diet. There were also three additional areas that approached significance for a time by technology interaction including for the choices for changing my child's diet (p=.09) and exercise (p=.07), and confidence in my ability to change my child's exercising regularly (p=.09). There were no significant (ns) time main effects noted for provider support for healthy eating or exercise suggesting the MI training alone did not improve the parents' perception of support from providers for changing behavior in children.

Table 7. Health Care Climate Questionnaire (HCCQ) completed by parents about the degree of support from their child's healthcare providers related to diet (section A) and exercise (section B). Answers were rated from not at all true (1) to very true (7).

					Analyses with first 2 time points		
Variable	**Group**	**T1**	**T2**	**T3**	Time Main Effect	Technology Main Effect	Time*Technology Interaction
A1: I feel that my healthcare providers have provided me with choices and options about changing my child's diet (including not changing).	Tech	6.19	6.52	6.57	n.s.	p=.05*	p=.09*
	Non-Tech	5.91	5.27	6.45			
A2: I feel my healthcare providers understand how I see things about my child's diet.	Tech	6.32	6.47	6.45	n.s.	n.s.	n.s.
	Non-Tech	6.11	5.32	6.39			
A3: My healthcare providers show confidence in my ability to make changes regarding my child's diet.	Tech	6.33	6.51	6.41	n.s.	n.s.	p=.04**
	Non-Tech	6.04	5.26	6.43			
A4: My healthcare providers listen to how I would like to do things regarding my child's diet.	Tech	6.40	6.54	6.56	n.s.	n.s.	n.s.
	Non-Tech	6.04	5.35	6.54			
A5: My healthcare providers encourage me to ask questions about my child's diet.	Tech	6.38	6.54	6.59	n.s.	n.s.	n.s.
	Non-Tech	6.02	5.54	6.49			
A6: My healthcare providers try to understand how I see my child's diet before suggesting any changes.	Tech	6.29	6.48	6.57	n.s.	n.s.	n.s.
	Non-Tech	6.01	5.36	6.43			
B1: I feel that my healthcare providers have provided me with choices and options about changing my child's exercising regularly (including not exercising regularly).	Tech	6.24	6.59	6.56	n.s.	n.s.	p=.07*
	Non-Tech	5.93	5.23	6.39			
B2: I feel my healthcare providers understand how I see things about my child exercising regularly.	Tech	6.36	6.56	6.55	n.s.	n.s.	n.s.
	Non-Tech	6.00	5.28	6.39			
B3: My healthcare providers show confidence in my ability to make changes regarding my child exercising regularly.	Tech	6.28	6.58	6.41	n.s.	n.s.	p=.09*
	Non-Tech	6.00	5.19	6.47			
B4: My healthcare providers listen to how I would like to do things regarding my child's exercise.	Tech	6.33	6.58	6.55	n.s.	n.s.	n.s.
	Non-Tech	6.03	5.31	6.16			
B5: My healthcare providers encourage me to ask questions about my child's exercise regime.	Tech	6.31	6.58	6.59	n.s.	n.s.	n.s.
	Non-Tech	6.07	5.37	6.37			
B6: My healthcare providers try to understand how I see my child's exercising before suggesting any changes.	Tech	6.29	6.58	6.52	n.s.	n.s.	n.s.
	Non-Tech	6.00	5.30	6.39			

*approaching significance (p<0.1); **p<0.05

IPC Results

Means for each IPC subscale are listed in Table 8. Overall, satisfaction with care was very high with means of 1.04-1.49 out 5 (1 being best) for reverse scored items and 3.57-4.78 out 5 (5 being best) for other items. Disrespectful office staff (IPC7) experienced a significant time*technology interaction between T1 and T2. Simple effects tests showed that there were not differences between groups at T1 ($F = 1.34$, n.s.), but there were at T2 ($F = 9.34$, $p<.01$). This is driven by the fact that scores did not change over time in the technology group ($F = .25$, n.s.) but they got worse in the non-technology group ($F = 8.12$, $p < .01$) where those in the non-technology group reported a greater likelihood of disrespectful office staff at T2 than they did at T1. No other interaction effects or main effects were significant for any of the other subscales.

Table 8. Interpersonal Process of Care Survey (IPC) completed by parents that measures the patient-clinician relationship. Twenty-nine questions were divided into seven subscales as listed below, with the direction of favorable scores. Answers were rated from never (1) to always (5).

					Analyses with first 2 time points		
Variable	**Group**	**T1**	**T2**	**T3**	Time Main Effect	Technology Main Effect	Time*Technology Interaction
IPC1: Hurried Communication	Tech	1.34	1.32	1.36	n.s.	n.s.	n.s.
(lower is better)	Non-Tech	1.34	1.34	1.27			
IPC2: Elicited Concerns, Responded	Tech	4.63	4.72	4.62	n.s.	n.s.	n.s.
(higher is better)	Non-Tech	4.55	4.56	4.67			
IPC3: Explained results, Medication	Tech	4.65	4.7	4.73	n.s.	n.s.	n.s.
(higher is better)	Non-Tech	4.46	3.99	4.69			
IPC4: Decision Making (Patient-centered)	Tech	4.32	4.41	4.53	n.s.	n.s.	n.s.
((higher is better)	Non-Tech	4.04	3.57	4.46			
IPC5: Compassionate, Respectful	Tech	4.71	4.75	4.74	n.s.	n.s.	n.s.
(higher is better)	Non-Tech	4.73	4.56	4.78			
IPC6: Discrimination	Tech	1.49	1.33	1.33	n.s.	n.s.	n.s.
(lower is better)	Non-Tech	1.41	1.62	1.23			
IPC7: Disrespectful Office Staff	Tech	1.07	1.09	1.04	p=.02*	p=.005*	p=.03*
(lower is better)	Non-Tech	1.14	1.43	1.1			

*p<0.05

Provider Process and Outcome Measures: Provider Behavior

Data Collection

The International Life Science Institute (ILSI) Research Foundation Assessment of Overweight in Children and Adolescents Survey was used to assess both process and outcome variables including attitudes, barriers, skills, approaches to assessment, and treatment methods of providers who work with overweight/obese youth. The survey consists of 35 questions, most with multiple parts.

Data Analysis

Composites were calculated for many survey questions to give an indicator of change by each topic area covered on the ILSI survey. Most questions were ranked using a 5-point Likert-type scale, from most of the time (5) to never (1). Attitudes included topics such as whether childhood overweight needs treatment and whether children will outgrow their overweight. Barriers were divided into patient/family barriers and clinic/setting barriers. Counseling proficiency included proficiency in the use of behavioral management strategies as well as modification of diet, activity, and sedentary behavior. Medical assessment covered screening for a variety of conditions such as hypertension, type 2 diabetes mellitus, genetic syndromes, and sleep disorders. Laboratory evaluations covered if a provider requests lipid profile, total cholesterol, glucose, or liver enzymes. Family history includes whether a provider asks about other family members who have conditions such as overweight, dyslipidemia, hypertension, and cardiovascular disease. Psychological/emotional assessment covers considerations such as poor self-esteem, depression, and readiness to change. Activity includes organized, unstructured, and routine activity and inactivity includes asking about any type of sedentary behavior. Referrals were calculated to include referral to a program or specialist such as dietitian, exercise specialist, or pediatric obesity program. Means for all of the above items were compared over time and between the technology and non-technology groups using repeated measures analyses conducted in a multilevel modeling framework (in SAS Proc Mixed).

Follow-up visits were calculated based on the percentage of providers who routinely schedule follow-up appointments for overweight/obesity every month or more often. Diet assessment includes the percentage of providers who obtain a diet history as part of their evaluation of overweight/obese youth. The number of providers who use BMI percentile and the correct cut-offs for overweight and obesity diagnosis was also included. Percentages for each of these variables were compared over time and between the technology and non-technology groups using repeated measures analyses conducted in a multilevel modeling framework (SAS Proc Glimmix).

Results

Table 9 shows survey results over time and by technology group. Many of the process and outcome variables reported by providers on implementation of the obesity guidelines improved over time, including counseling proficiency, medical assessment, psychological/emotional assessment, activity, inactivity, and diet

assessment. When comparing results by technology group, few differences were significant. Providers' report of clinic/setting barriers in the treatment of childhood overweight/obesity decreased (improved) in the non-technology group, while increasing in the technology group (p=.009). Follow-up visits also were different between groups (p=.05), with the non-technology group improving from 23% to 50% for providers who schedule follow-up visits at least once per month, while the technology group stayed relatively stable near 40% over time. The psychological/emotional assessments approached significance (p=.06) with the technology increasing over time.

Table 9. Self-reported attitudes, barriers, assessment, and treatment practices of providers.

Variable	Question Scale	Group	T1	T2	T3	Time Main Effect	Technology Main Effect	Time by Technology Interaction
Attitudes	5-point	Tech	4.12	4.29	4.38	0.55	0.74	0.08
		Non-Tech	4.27	4.23	4.17			
Barriers, Patient/Family	5-point	Tech	4.11	4.20	4.05	0.52	0.19	0.07
		Non-Tech	4.19	4.42	4.49			
Barriers, Clinic/Setting	5-point	Tech	2.82	3.12	3.18	0.77	0.29	0.009
		Non-Tech	3.06	2.53	2.58			
Proficiency, Counseling	3-point	Tech	1.87	2.13	2.27	0.0007	0.94	0.88
		Non-Tech	1.88	2.15	2.21			
Medical Assessment	5-point	Tech	3.29	3.53	3.74	0.009	0.16	0.92
		Non-Tech	3.11	3.23	3.45			
Laboratory Evaluations	5-point	Tech	4.05	4.28	4.40	0.07	0.12	0.96
		Non-Tech	3.73	3.88	4.01			
Family History	5-point	Tech	3.73	3.95	3.99	0.06	0.49	0.35
		Non-Tech	3.68	3.72	3.95			
Psychological/Emotional Assessment	5-point	Tech	3.82	4.29	4.33	0.0004	0.29	0.06
		Non-Tech	3.95	3.89	4.02			
Activity	5-point	Tech	4.39	4.34	4.72	0.02	0.99	0.93
		Non-Tech	4.37	4.41	4.67			
Inactivity	5-point	Tech	4.42	4.83	4.81	0.001	0.50	0.69
		Non-Tech	4.33	4.57	4.78			
Referrals	5-point	Tech	2.62	2.61	2.65	0.17	0.33	0.17
		Non-Tech	2.13	2.55	2.56			
Follow-up Visits	Percentage	Tech	40.00%	33.33%	36.36%	0.07	0.43	0.05
		Non-Tech	23.53%	66.67%	50.00%			
Diet Assessment	Percentage	Tech	64.29%	84.62%	81.82%	0.04	0.76	0.11
		Non-Tech	64.71%	60.00%	83.33%			
BMI Percentile Assessment	Percentage	Tech	100%	100%	100%	Model Couldn't Be Estimated		
		Non-Tech	72.22%	91.67%	91.67%			
Distinguish Between Overweight/Obese	Percentage	Tech	100%	100%	100%	0.08	0.04	0.08
		Non-Tech	72.22%	91.67%	100%			
Cut-off for Overweight	Percentage	Tech	80.00%	83.33%	81.82%	0.24	0.70	0.26
		Non-Tech	55.56%	83.33%	91.67%			
Cut-off for Obese	Percentage	Tech	100%	90.91%	100%	0.29	0.07	0.14
		Non-Tech	66.67%	81.82%	90.91%			

Provider Outcome: Chart Audit Results

Data Collection

Medical records from a random sample of youth 5-12 years (n=32/clinic) making well-child or sports-physical visits during a 3-6 month period prior to each of the three data collection points were reviewed for documentation. Charts were examined for documentation of: BMI percentile, accurate weight diagnosis based upon the BMI percentile for age and sex, BP percentile, ordering appropriate laboratory assessment of youth aged 10 years and older with a BMI ≥ 95th percentile. SBHC staff members were instructed to generate a list of eligible patients seen for a well-child care or sports physical in the 3-6 month period prior to each data collection time point (from EHR, billing data, or appointment book). Staff provided the last three digits of the medical record identification number to the statistician. The statistician used a random-number generator to randomly select 32 charts from this list for the audit. Training via telephone conference call with PowerPoint presentation on the process of sampling charts, extracting data, and completing the data abstraction forms took place prior to the first audit period. Due to difficulty obtaining 32 chart audits at some sites, the data

collection period was extended and sites were encouraged to audit all charts of well child visits during the data collection period with some sites exceeding the 32 chart target and some returning no charts. Chart audits ranged from 2 - 40 charts at the sites that provided chart audits. Each of these independent samples of patients serves as a snapshot-in-time evaluation of providers' practice behaviors. The SBHC faxed the Teleform chart audit forms to the research team at the end of the day. Status of chart audits was discussed during the monthly telephone calls to answer questions and to address any challenges.

Data Analysis

Providers were considered adherent to laboratory assessment guidelines if they ordered labs when BMI ≥ 95th percentile and ≥ 10 years of age and didn't order labs when not indicated (less than 10 years of age and/or BMI < 85th percentile). Data were not available regarding risk factors (i.e., family history) in the chart audit, therefore assessment of adherence was not possible for overweight children ≥ 10 years. Providers were considered to have missed a diagnosis of overweight if the child had a BMI ≥ 85th percentile and < 95th percentile and they did not exclusively diagnose the child as overweight (i.e., they either did not diagnose the child as overweight or lacked specificity and diagnosed the child as both overweight and obese). Providers missed a diagnosis of obesity of the child had a BMI ≥ the 95th percentile and they did not exclusively diagnose the child as obese.

Regression models were estimated to examine the impact of time and technology group on adherence. These models were estimated as logit models in a multilevel framework to account for charts being nested within providers using SAS Proc Glimmix. Time was treated as a between-subjects factor because different charts were audited at each time point and therefore did not represent the same children being followed.

Results

Demographics

Table 10 displays child demographic information, by time (T1, T2, T3). At all three time points, children were approximately 9 years old and about half were female. The race/ethnicity of the children served was diverse, with approximately one-third non-Hispanic white, 15%-19% non-Hispanic black, and 39%-47% Hispanic. The majority of the children had insurance and a strong majority received free lunch. Estimates of overweight ranged from 17%-19%, and estimates of obesity ranged from 23%-26%. Most of the demographic characteristics did not differ by time, as is to be expected given that charts were randomly selected at each data collection time point. A greater percentage of children were insured at T2 compared to T1 and T3 ($p<0.05$), and there were racial/ethnic differences across time ($p<0.05$), driven primarily by a lower percentage of Hispanic children at T3 compared to T1 and T2.

Table 10. Child/family demographic characteristics at each time point.

	T1	T2	T3	Test Statistic
Number of Charts	850	691	612	---
Age	9.21 (2.30)	9.21 (2.26)	9.00 (2.40)	F (2, 2082) = 1.84
Sex (% Female)	49.76%	53.72%	51.08%	X^2 (df=2) = 2.40
Race/Ethnicity				
non-Hispanic White	31.85%	34.31%	36.75%	X^2 (df=6) = 14.91*
non-Hispanic Black	14.59%	17.37%	19.26%	
Hispanic	47.08%	43.94%	39.40%	
Other	6.47%	4.38%	4.59%	
Insured	70.28%	75.78%	70.86%	X^2 (df=2) = 6.36*
Free Lunch	88.81%	84.21%	88.59%	X^2 (df=2) = 5.04
Percent Overweight (≥85th and < 95th percentile)[a]	17.46%	18.36%	19.08%	X^2 (df=2) = 0.54
Percent Obese (≥95th percentile)[a]	25.56%	25.80%	23.17%	X^2 (df=2) = 1.37

*p<0.05; [a]Weight category was calculated by research team using reported BMI percentile in chart audit.

Adherence to clinical guidelines over time examined by technology group

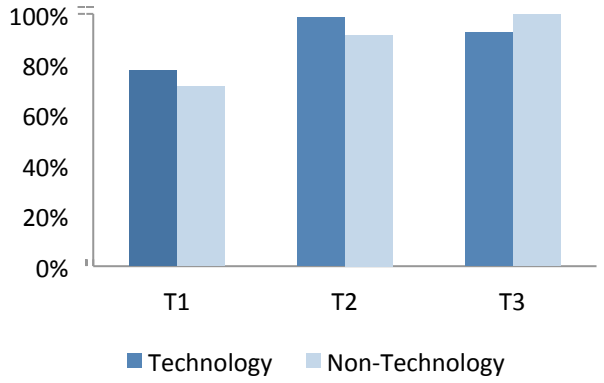
Table 11 indicates the clinician adherence to each component of the guidelines at each time point. The "Time Main Effect" column indicates a significant improvement in adherence to guidelines after training for BMI percentile documentation, BP percentile documentation, as well as diagnosis of overweight and obesity. The "Technology Main Effect" column suggests an overall difference between the groups for diagnosis of overweight and obesity. Finally, the "Time by Technology Interaction" column suggests that the technology did not significantly improve adherence to the providers' documentation.

Table 11. Provider adherence to guidelines by documentation from chart audits.

Variable	Group	T1	T2	T3	Time Main Effect	Technology Main Effect	Time*Technology Interaction
BMI Percentile Documentation	Tech	77.46%	98.66%	92.59%	p=0.029	p=0.71	p=0.69
	Non-Tech	71.34%	91.54%	99.65%			
BP Percentile Documentation	Tech	37.05%	56.72%	55.86%	p<0.0001	p=0.30	p=0.96
	Non-Tech	21.28%	32.60%	28.82%			
Overweight Accurately Diagnosed	Tech	60.00%	67.14%	83.02%	p=0.026	p=0.01	p=0.72
	Non-Tech	30.00%	39.22%	61.02%			
Obese Accurately Diagnosed	Tech	69.88%	69.90%	85.29%	p=0.002	p=0.05	p=0.09
	Non-Tech	28.21%	52.24%	63.24%			
Labs Accurately Ordered	Tech	76.06%	80.47%	80.97%	p=0.25	p=0.49	p=0.71
	Non-Tech	85.44%	78.84%	84.21%			

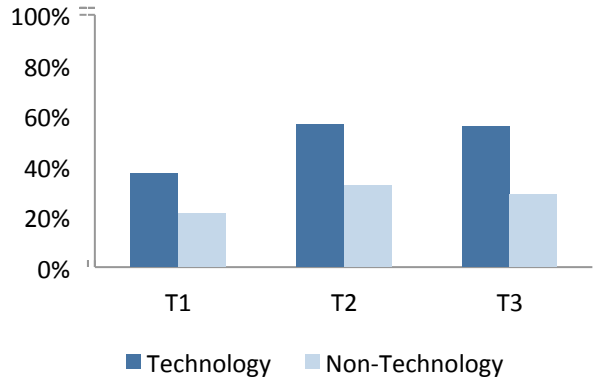
BMI Percentile Documentation. Patterns of BMI percentile documentation adherence behaviors based on time and technology group are depicted in Figure 2. There was a time main effect on BMI percentile documentation (p = 0.029), where post hoc contrasts demonstrated a significant improvement from T1 to T2 and T3 (p = 0.009), but no change from T2 to T3 (p = 0.27). There was an impact of technology group from T1 to T2, F=6.62, p=0.01 time by tech interaction. However, there was no impact of technology group, either as a main effect of group (p = 0.71) or through interactions with time (p = 0.69) when time three data were added. These results therefore indicate that adherence to BMI documentation guidelines improved from 74.12% at T1 to 95.37% at T2 and that this improvement was maintained at T3 (95.92%, irrespective of whether providers received the technology or not).

Figure 2. BMI percentile documentation, by time and technology group.



Blood Pressure Percentile Documentation. Figure 3 depicts changes in documentation of blood pressure percentile over time and by technology group. There was a main effect of time on blood pressure percentile documentation (p < 0.0001). Consistent with the results for BMI percentile documentation, post hoc contrasts demonstrated a significant improvement from T1 to T2 and T3 (p < 0.0001), but no change from T2 to T3 (p = 0.38). There was again no impact of technology group (p = 0.30 for the technology main effect and p = 0.96 for the time by technology interaction). Adherence to blood pressure documentation guidelines therefore improved from 28.28% at T1 to 45.59% and 43.14% at T2 and T3, and this improvement did not depend on provider technology status.

Figure 3. Blood pressure percentile documentation, by time and technology group.



Proportion of Overweight Accurately Diagnosed by Provider. The proportion of overweight children correctly classified by their provider is shown in Figure 4, by time and technology group. There was a main effect of time on correct overweight diagnosis (p = 0.026). Post hoc contrasts showed that adherence did not significantly improve from T1 to T2 (p = 0.41), but did improve from T2 to T3 (p = 0.04). There was a main effect of technology group (p = 0.01), where adherence scores were higher overall for the technology group compared to the group that did not receive technology. However, technology status did not interact with time (p = 0.72), indicating that higher scores in the technology group were consistent across all time points. To summarize, providers had improved their correct diagnosis of overweight by the end of the study – from 40.91% at T1 to 71.43% at T3. Providers receiving technology were more likely to correctly diagnose children as overweight at all time points, even at T1 before the technology was available in the clinic.

Proportion of Obese Accurately Diagnosed by Provider. Figure 5 depicts the proportion of providers who correctly diagnosed obesity in children ≥ the 95th BMI percentile. There was a main effect of time on obesity diagnosis accuracy (p = 0.002), where providers improved in accuracy from T1 to T2 (p = 0.04) and then showed additional improvement from T2 to T3 (p = 0.03). Technology group made a difference as a main effect (p = 0.05) but not through an interaction with time (p = .09), where adherence was higher in the technology group at all time points. Adherence to obesity diagnosis guidelines therefore improved significantly over time from 46.69% to 62.94% to 74.26%, irrespective of assignment to technology condition.

Adherence to Laboratory Assessment Guidelines. Patterns of adherence to laboratory assessment guidelines are shown in Figure 6. There was no change in adherence to laboratory assessment guidelines over time (p = 0.25), nor was there an impact of technology group either as a main effect (p = 0.49) or through an interaction with time (p = 0.71). Adherence to laboratory assessment guidelines ranged from 79.74% to 82.53% across the three time points of the study.

Figure 4. Proportion of overweight accurately diagnosed, by time and technology group.

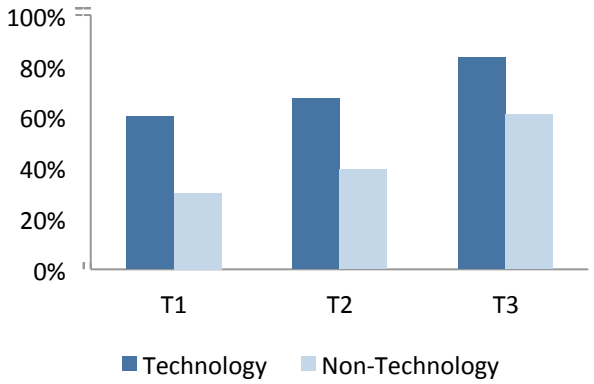


Figure 5. Proportion of obese accurately diagnosed, by time and technology group.

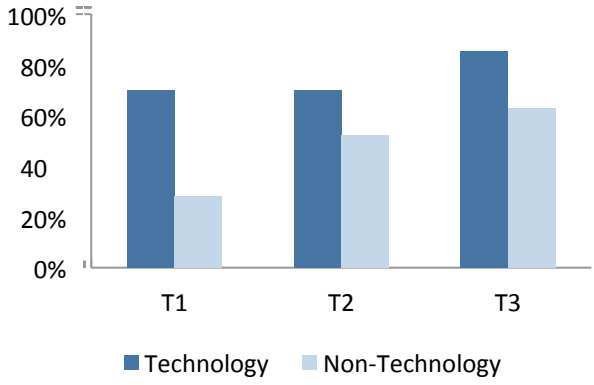
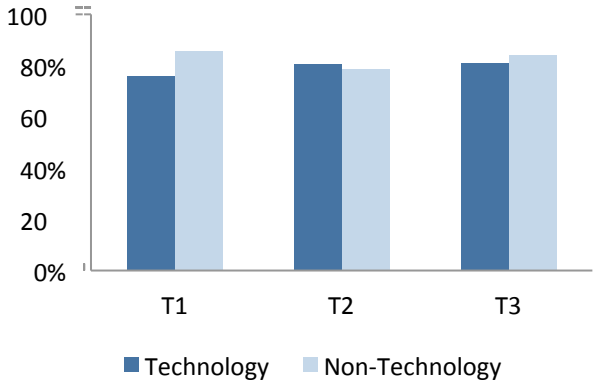


Figure 6. Adherence to laboratory assessment guidelines, by time and technology group.



System Changes: Chronic Care Model Element Survey (CCMES) Results

Data Collection

The Chronic Care Model Elements Survey (CCMES) is a 9-item survey that assesses the extent to which elements of the chronic care model are used in the routine care of patients in a practice. For all items, the response values ranged from (1) "never" to (5) "always." Questions are listed in Table 13. The total score is created as the mean of the 9 items, with the higher indicative of greater use of the elements of the CCM. If there were multiple providers per site, their scores were averaged into a single score.

Data Analysis

The total score and each of the nine items were compared among sites over time (T1, T2, T3) and by technology group using repeated measures analyses, where a significant time by technology interaction signifies that changes over time were dependent upon technology group.

Results

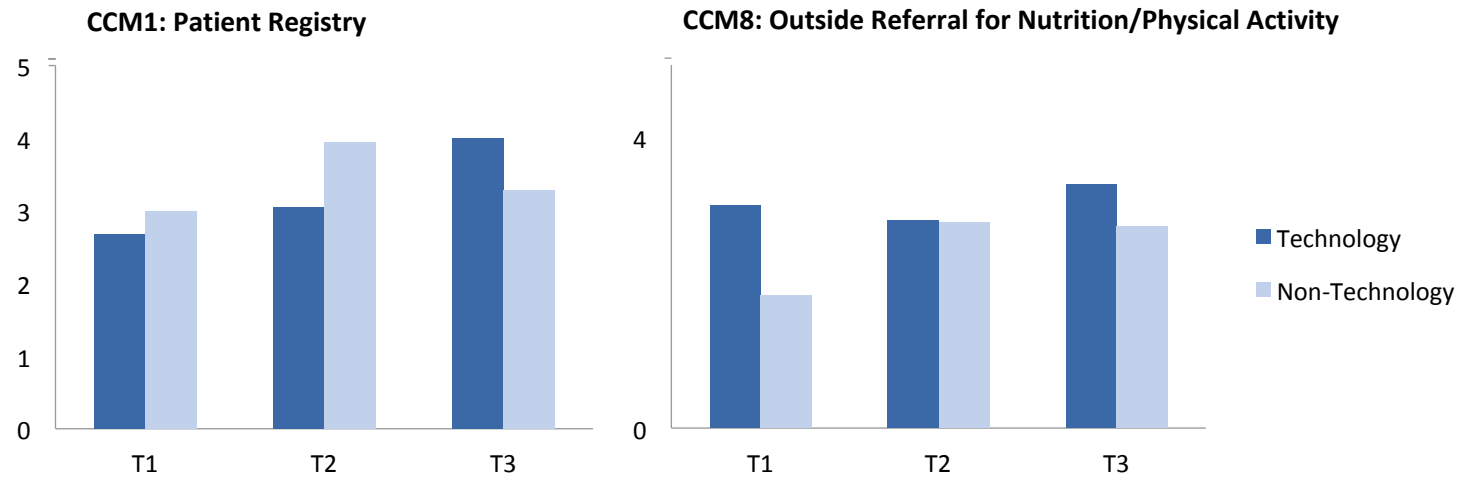
Means for each element are presented in Table 12 by technology group. The interaction between time and technology was significant for both CCM1 and CCM8 (Figure 7). For CCM1, there was a greater improvement in the non-technology group compared to the technology group from T1 to T2; however, at T3, the pattern of means flipped where scores were higher in the technology group. The time*technology interaction for CCM8 was primarily driven by technology group differences at T1 where the technology group had significantly higher scores than the non-technology group.

Table 12. Chronic Care Model Elements Survey (CCMES). Means (±S.D.) are listed for the technology and non-technology groups at each time point.

	T1		T2		T3		Time*Technology Interaction
	Tech	Non-Tech	Tech	Non-Tech	Tech	Non-Tech	
CCM Total	3.27 (0.42)	3.16 (0.40)	3.38 (0.60)	3.48 (0.43)	3.75 (0.59)	3.42 (0.44)	F = 2.56, p = .09
CCM1: Use a patient registry to identify and/or track care of your patients	2.67 (1.56)	3.00 (1.15)	3.05 (1.06)	3.94 (0.73)	4.00 (1.18)	3.28 (0.97)	F = 4.13, p = .02*
CCM2: Use a tracking system to remind patients about needed visits or services	3.76 (1.09)	3.39 (1.27)	3.59 (1.20)	3.28 (1.48)	4.09 (0.94)	3.50 (0.94)	F = 0.14, p = .87
CCM3: Follow-up with patients between visits by telephone (you or staff)	2.94 (0.55)	3.11 (0.82)	3.18 (0.75)	3.06 (0.53)	3.55 (1.04)	3.06 (0.53)	F = 1.80, p = .18
CCM4: Use published practice guidelines as the basis for your management	3.76 (0.42)	3.83 (1.12)	4.14 (0.78)	4.22 (0.67)	4.27 (0.65)	4.06 (0.73)	F = 0.31, p = .73
CCM5: Involve office staff in identifying and reminding patients in need of follow-up or other services	4.00 (0.77)	4.28 (0.44)	4.18 (0.98)	4.22 (0.44)	4.36 (0.81)	4.17 (0.71)	F = 1.39, p = .26
CCM6: Refer patients in setting and attaining self-management goals	3.82 (0.40)	3.69 (0.88)	3.73 (0.65)	4.00 (0.50)	4.27 (0.47)	3.94 (0.88)	F = 3.24, p = .052
CCM7: Refer patients to someone within your practice for education about their nutrition or physical activity	2.21 (1.38)	2.67 (0.83)	2.23 (1.60)	2.94 (1.24)	2.55 (1.63)	3.00 (1.12)	F = 0.23, p = .80
CCM8: Refer patients to someone outside your practice for education about their nutrition or physical activity	3.06 (0.84)	1.83 (0.79)	2.86 (0.71)	2.83 (0.61)	3.36 (1.21)	2.78 (0.67)	F = 6.19, p = .005*
CCM9:Use flow sheets to track critical elements of care	3.18 (1.17)	2.72 (1.52)	3.45 (1.21)	2.83 (1.54)	3.27 (1.56)	3.00 (1.00)	F = 0.18, p = .83

*p<0.05

Figure 7. Means by group across the three time points for CCM1: Patient registry and CCM8: Outside referral for nutrition/physical activity. Time*technology interaction was significant (p<0.05) for both questions.



Focus Groups/Exit Interviews

Data Collection

The original plan was to conduct focus groups with the adopters and non-adopters in each group (technology and non-technology). After examination of the measures of adherence to guidelines (chart audits) and technology adoption from the tech group, clear cut points for adopters and non-adopters could not be determined. In addition, it was not possible to coordinate a time to schedule focus groups for busy providers in different time zones. Therefore, a combination of focus groups and exit interviews were conducted. Two focus groups (one each with the technology and non-technology groups) and five interviews were conducted with a total of ten participants (six from the technology group and four from the non-technology group). Individual interviews were conducted with participants who could not attend the focus groups using purposive sampling to optimize our understanding of the virtual collaborative experience for participants from geographically diverse areas. The focus groups and exit interviews occurred after the final data collection (T3) was complete. One focus group was conducted via video conference call and the other over audio conference call due to different capabilities within clinics. Two individual interviews were conducted in person and the other three via telephone. Questions were asked to learn more about providers' perspectives on barriers, facilitators, and impact of the intervention (technology or non-technology group) on improving evidence-based recommendations for obesity care in their clinic. Participants were asked to describe their experience in implementing the guidelines, as well as the facilitators and barriers to making the changes.

Data Analysis

Focus group data were analyzed using the constant comparative technique and data management was facilitated by use of Atlas.ti (Version 7.5.1, Berlin, Germany). Two members of the research team independently coded quotes for each theme, which were divided into categories and exemplar quotes identified to describe the themes and categories.

Results

The focus groups revealed the following themes: program implementation, benefits of participating in the collaborative, as well as facilitators and barriers for participating in the collaborative. The technology group reported on implementation of the decision-support technology, benefits, and challenges. See Table 13 for the categories in each theme and exemplars for each category. The most frequent categories for implementation were strategies used to adapt the guidelines for their population and advice for the research team for future work with virtual collaboratives. The most frequent category for benefits of the collaboration was practice changes, which included many examples of changes the clinics made to implement the guidelines. Facilitators identified by participants that helped them implement the guidelines were connecting with community resources. The main barrier to implementing the guidelines was overwhelmingly reported by participants as the impact on workflow. The technology group participants outlined their strategies for implementing the technology along with the benefits and challenges to use of the technology in their practice setting.

Table 13. Themes and exemplar quotes from focus groups and exit interviews.

Themes	Number of Quotes[a]	Exemplar
Program Implementation		
Adapting Guidelines	49	"Communicate the information to families…in their languages."
Advice for Future	50	"Pass to pool or rec center would be better incentive." "The only thing I would add would be jump ropes that the parents and kids could use."
Feeling Overwhelmed	13	"I was, like, going crazy and it was…very stressful, very frustrating; my visits were like twice as long. I had kids lining up outside of my office and then after discussing my frustrations, I learned I didn't need to apply all the skills at once."
Benefits of Collaboration		
Patient Engagement	33	"I created the visual stuff…'Look at the wrapper and tell me how much fat is in that compared to red hot Cheetos?' Those are their world, so having hands-on things helped."
Patient Outcomes	13	"We started to see great results. In fact I just had a kiddo in yesterday who had lost 15 pounds in one year. I would have never seen that three years ago."
Practice Changes	90	"Because of this whole obesity initiative, we were able to get centrifuges in all of our school based health center clinics…and we got all of our LPNs trained in phlebotomy."
Facilitators		
Champion	9	"I wanted to say that if it weren't for [my clinical assistant], it would've taken a lot longer to [implement the technology]."
Community Resources	70	"I send kids to a program at the YMCA " "Our school has some sports and arts programs, and after-school programs." "We work really vigilantly to get kids insurance coverage."
Staff and Admin Support	49	"The health educator...would sit with the kids and explain the questions if they didn't understand, and explain the answers." "The office assistant was an amazing woman. She had great buy-in and even when I wasn't there...students would drop in and say 'oh, I just want to check this' or 'I just want to run this by you.' I really gave her an awful lot of autonomy with the education piece because she could do it...she had done a lot of the training."
Barriers		
Cost	24	"When I have a lot of uninsured kids and I'm drawing a lot of lab tests, I'm sure there's a cost there."
Data Collection Challenges	44	"I thought that the questionnaire was a little complicated." "The surveys were very lengthy…after page two, I could see parents start to get frustrated with the length of the survey."
Lack of Community Resources	15	"Very minimal resources available in our very rural area."
Lack of Engagement	12	"We have a front office person who didn't really have any buy-in."
Patient/Family	82	"A tremendous number of obese parents that really did not want to address it with their children."
Workflow	96	"It's really, really tough when you already have a skeleton staff to begin with." "I felt constantly rushed and constantly under pressure, and I never felt that I accomplished what I wanted to."
Technology		
Benefits	24	"[The technology] just kind of brings your attention to it more, and I kind of liked it, having a copy for me and a copy for them. Also recommendations on what to do based on eating, drinking or exercise, and then following back with them to see if they actually did any of it. And also having them pick what they wanted to do or come up with their own ideas, you know the whole MI piece."
Challenges	42	"We were having issues with our internet server in our clinic so we had to use the school's internet to access the programs on the iPad." "The challenge came with the little kids because we had to show them how to navigate [the technology]."
Implementation	16	"I believe it took about a month...first find out who was the IT person from our schools and then put in a ticket order through the hospital so they would come down to our sites and give us administer rights to download the Heart Smart and then...it was easy for us to set up the iPads."

[a]Number of quotes based on coding by two independent coders.

Discussion

Despite decades of work on childhood obesity, our baseline data suggests that there is failure of providers to implement the guidelines into practice without support. Participants reported high satisfaction with the virtual collaborative. Focus groups indicated the participants identified how they improved their practice and the value of a team approach to practice change. Completion of the learning sessions was variable, however, the majority of providers (64%) completed 75% of the training but only 11% completed all the modules. Participation in the virtual collaborative resulted in significant improvements in adherence to guidelines with sustained improvement over time from the self-reported measures on knowledge, attitudes, and barriers, as well as the chart audit data. Documentation of BMI was significantly better in the technology group after training but the non-tech group improved as well by T3, perhaps due to implementation of electronic health records in many of the sites during the course of the study.

The data from the parent surveys suggests that the technology had a positive impact on parents' perception of healthcare provider showing confidence in their ability to make changes regarding the child's diet (p=.04). There were also positive trends reported in the impact of the technology for providers offering choices for changing my child's diet (p=.09) and exercise (p=.07), and confidence in my ability to change my child's exercising regularly (p=.09).

Measuring patient-level data was not the focus of this study, therefore, the impact of the training and tailored patient handouts on influencing patient behavior change was not evaluated. However, significant differences between the technology and non-technology groups were noted on parents' perception of the interpersonal processes of care with technology groups maintaining low scores (lower score better) for disrespectful staff over time compared to higher scores for the non-technology group over time. The technology also appeared to have a positive impact on some components of the chronic care model over time, including the patient registry (p=.02) and outside referrals (p=.005). Additionally, self-management goals (p=.052) and total CCMES score (p=.09) approached significance. HSK creates a patient registry for practices and allows the inclusion of referral sources to be included into the tailored patient education materials that are generated. The focus groups reported the many practice changes that centers implemented in response to participation in the virtual collaborative including a dedication to improvement in identification, assessment, and counseling using motivational interviewing. These findings were consistent with the ILSI provider self-report findings.

Comparison of the impact of the technology-enhanced group with the training only group was difficult to ascertain due to small sample size and failure of randomization to achieve equal groups at baseline. Implementation of the technology in the 12 sites that received the technology was variable with some sites completely adopting the technology and using it for every well child visit and others rarely using the technology due to competing demands, lack of staff, as well as internet and technical issues with implementation. Many of the non-technology sites were implementing electronic health records during the study period which may have also influenced their ability to document BMI percentile and accurately diagnosed children as overweight or obese. Initial engagement in the project was higher in the technology group perhaps due to knowledge that they were randomized to the technology group. Providers in the technology group sustained a higher level of engagement throughout the project with a higher percentage of sites completing full data collection.

Conclusions

SBHCs provide care to overweight and obese children in much higher proportions than the general population. Providing a virtual obesity collaborative to providers distributed across the nation including urban, rural, and remote locations was feasible. Participation in a virtual obesity collaborative significantly improved the providers' adherence to the obesity guidelines. Further work to determine how many and which learning modules result in practice change needs to be done. Future research may be enhanced by randomizing the SBHCs after baseline data is collected and analyzed to match the centers on baseline variables of interest. Additionally, the impact of technology at the patient level, including the patient tailored materials, needs to be evaluated and an enhanced process (monthly case coaching) for facilitating the adoption of technology into the clinic work flow throughout the project is recommended.

LIST OF PUBLICATIONS AND PRODUCTS

Manuscripts – accepted

- Gance-Cleveland B, Gilbert K, Gilbert L, Dandreaux D, Russell, N. Decision support to promote healthy weights in children. *J Nurse Pract*. 2014; in press.
- Aldrich H, Gance-Cleveland B, Schmiege S, Dandreaux D. Identification and assessment of childhood obesity by school-based health center providers. *J Ped Health Care*. 2014; in press.
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- Militello L, Gance-Cleveland B, Aldrich H, Kamal R. A methodological quality synthesis of systematic reviews on computer-mediated continuing education for healthcare providers. *Worldviews on Evidence-Based Nurs.* 2014;11(3):177-186.

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Manuscripts – under review

- Gance-Cleveland B, Aldrich H, Dandreaux D, Oetzel K, Schmiege S. A virtual childhood obesity collaborative: Satisfaction with online continuing education. Under review at *J Ped Health Care*.
- Gance-Cleveland B, Aldrich H, Schmiege S, Coursen C, Dandreax D, Shaibi G, Gilbert L. Child's ethnicity as a factor in clinican adherence to childhood obesity recommendations. Under review at *J Spec Pediatr Nurs.*

Manuscripts – under development

- Gance-Cleveland B, Schmiege S, Aldrich H, Stevens C, Gilbert K. Reliability and validity of HeartSmartKids: Cardiovascular risk assessment. To be submitted to *J Nurs Meas*.
- Olson J, Aldrich H, Callahan T, Gance-Cleveland B. Characterization of childhood obesity in urban and rural Michigan. To be submitted to the *J Spec Pediatr Nurs.*

Presentations

- Gance-Cleveland B. Reliability and validity of HeartSmartKids: Cardiovascular risk assessment for children 2-18 years. Council for Advancing Nursing Science; 2014 Sept; Washington, D.C.
- Gance-Cleveland B. Overview of guidelines for childhood obesity including motivational interviewing. Nurse Practitioners Symposium; 2014 Jul; Keystone, CO.
- Gance-Cleveland, B. Implementing culturally-sensitive childhood obesity prevention programs. Family Medicine Annual Review; 2014 Jun; Estes Park, CO.
- Gance-Cleveland B. Child's Ethnicity as a factor in parental satisfaction with care. Western Institute of Nursing; 2014 Apr; Seattle, WA.
- Gance-Cleveland B. Using the health disparities collaborative and E-Learning to improve the quality of obesity care in school-based health centers. National Association of Pediatric Nurse Practitioners Annual Conference; 2014 Mar; Boston, MA.
- Gance-Cleveland B. Motivational interviewing to promote healthy weight in children. Phoenix Children's Hospital Annual Obesity Conference; 2014 Mar; Phoenix, AZ.
- Gance-Cleveland B. Health information technology to support clinical decision making: Findings from a 24-site comparative effectiveness trial. Grand Rounds Children's Hospital CO; August 2013; Aurora, CO.
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